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HEWLETT-PACKARD COMPANY
Intellectual Property Administration
P.O. Box 272400
Fort Collins, CO 80527-2400

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SIANGCHIN, KEVIN	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/895,689	Applicant(s) LUO, HUITAO	
	Examiner Kevin Siangchin	Art Unit 2623	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on *2001 July 2* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *2/2003, May 14*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Detailed Action

Drawings

1. The drawings are acceptable. However, the handwritten captions of the Applicant's drawings, though marginally legible, should be replaced with typed captions to ensure proper reproduction and visual clarity.

Specification

2. Though not warranting an objection of the specification (or claims), the Applicant usage of the word *factor* when describing the tone mapping function, in the specification and the claims, may be somewhat misleading. *Factor* can imply some multiplicative process, which is not disclosed. The Applicant may be better served by substituting the word *factor* with the word *parameter*, where appropriate.

Objections

3. The disclosure is objected to because of the following informality. On page 24 of the Applicant's disclosure, the variables *width* and *height*, found in equation (8), are undefined. The values of the these variables and/or what they are intended to represent cannot be easily discerned from the Applicant's disclosure. Appropriate correction is required.

Claims

Objections

4. Claims 7 and 17 are objected to because of the following informalities. These claims refer to *noise issue*. The term *noise issue* has no general meaning in the field of image enhancement or in all of signal processing, for

that matter. As is evident from second paragraph on page 21 of the Applicant's disclosure, the Applicant intends *noise issue* to mean the *matter, subject, or problem of noise.* It should be clear, therefore, that, in claims 7 and 17, the word *issue* can be dropped (or, more preferably, changed to the word *information*) without substantively effecting the intended meaning of these claims. Removing the word *issue* from claims 7 and 17 not only makes these claims more consistent with the Applicant disclosure, but avoids the aforementioned confusion that may arise with usage of the term *noise issue.*

5. The word *analysis* is misspelled in claim 1 ("alanysis" – claim 1, line 6). The word *determined* is misspelled in claim 1 ("determinined" – claim 1, line 10). Similar typographical errors can be found in claims 11 and 18.

6. Claim 9 recites the limitation "said lookup table". There is insufficient antecedent basis for this limitation in the claim. Changing the claim 9 to depend on claim 8 would rectify this problem. It will be assumed, henceforth in this document, that claim 9 depends on claim 8. Appropriate correction is required.

Rejections Under 35 U.S.C. § 102(b)

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 1-4, 6, 8-9, 11-14, 16-20, and 23-24 are rejected under 35 U.S.C. 102(b) as being anticipated by Nakai et al. (U.S. Patent 5,539,523).

9. *The following is in regard to Claim 1.* Nakai et al. disclose a method for making color corrections on stored image data. This method includes:

(1.a.) Locating human faces within the digital image. See, for example, Nakai et al. column 2, lines 43-47 and column 8, lines 14-24. Note there that extraction of the facial areas necessarily entails their location.

(1.b.) i. Analyzing the located and extracted human faces. See, for example, the analyses discussed in Nakai et al. column 10, lines 17-29 and column 2, equation (3) and lines 43-47.

ii. Analyzing the entire digital image. This could, for example, entail the digital image analyses discussed in Nakai et al. column 11, lines 43-52 and column 2, lines 26-34.

(1.c.) i. Determining a tone mapping function for enhancing the image quality of said digital image. See, for example, Nakai et al. column 4, lines 10-38, in conjunction with Fig. 10 and column 10, lines 34-51. The tone mapping is accomplished by the application of the various color correcting matrices corresponding to disparate extracted areas of the image (e.g. matrices A, B, and C of Nakai et al. Fig. 10). See Nakai et al. column 8, lines 14-24, equations (1)-(2) and column 4, lines 10-38. Therefore, these matrices can, collectively, be regarded as the tone mapping function[1].

ii. According to Nakai et al. (Nakai et al. column 8, lines 14-24), included in this set of matrices is a normal correcting matrix and a flesh correcting matrix. These are derived from an analysis of the entire image (Nakai et al. column 2, lines 26-34) and an analysis of the facial, flesh-tone regions (Nakai et al. column 2, lines 47-53), respectively.

(1.d.) Applying the tone mapping function (i.e. the aforementioned collection of correction matrices) to the digital image so as to produce an enhanced digital image. Note steps 6 and 10 of Nakai et al. Fig. 10.

It has thus been shown that the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 1. Therefore, the teachings of Nakai et al. anticipate the method of claim 1.

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1 Note that these matrices provide a relation from all colors (i.e. the entire domain) of the input image to the corrected output colors. Though conditionally applied over the domain of the image, these matrices can collectively be considered, in a mathematical sense, a function mapping the input (uncorrected) image colors to the output (corrected) image colors.

10. *The following is in regard to Claim 2.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 1. The method of Nakai et al. (steps (1.a)-(1.d)) is automatic. See, for example, Nakai et al. column 6, lines 35-40. It has thus been shown that the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 2. Therefore, the teachings of Nakai et al. anticipate the method of claim 2.

11. *The following is in regard to Claim 3.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 1. In Nakai et al.'s method, the face area is "extracted therefrom through a process such as removing separate points, expanding, contracting, labeling and recognizing the shape" (Nakai et al. column 2, lines 43-47). This process effectively constitutes a face detection algorithm applied to the digital image. It has thus been shown that the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 3. Therefore, the teachings of Nakai et al. anticipate the method of claim 3.

12. *The following is in regard to Claim 4.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 1. By providing a mapping from uncorrected *flesh tones* to corrected *flesh tones,* the tone mapping function (see above) of Nakai et al.'s method incorporates "psychological factors". This is implied, for example, by Nakai et al. in column 2, lines 35-38. "Signal factors" [2] influencing the tone mapping function of Nakai et al.'s method can include everything from the colors of the input digital image to the histogram derived from the digital image (Nakai et al. column 11, line 52). That is, the tone mapping function derived according to the method of Nakai et al. includes both "psychological factors" and "signal factors". In this manner, the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 4. Therefore, the teachings of Nakai et al. anticipate the method of claim 4.

13. *The following is in regard to Claim 6.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 4. To further enhance the image, Nakai et al. supplements the color correction discussed above with a filtering process (Nakai et al. Fig. 12, block 40) intended to

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2 Here, the signal under consideration is the input image. Signal factors will be interpreted as being the properties of such a signal.

enhance the contrast of the output image (Nakai et al. column 11, lines 65-67). If one considers this filter coupled with the aforementioned correction matrices (as shown in Nakai et al. Fig. 12) as representing the tone mapping function, then that function would include image contrast as a "signal factor"[3]. Since the facial region is a subset of the image, facial contrast would similarly be a signal factor.

14. The tone mapping function of Nakai et al. also inherently incorporates the bit-resolution[4] of the input image. This is determined by the quantization (24-bit resolution) of the input image. See Nakai et al. column 11, lines 19-23. Therefore, the tone mapping function of Nakai et al.'s image enhancement method further includes the signal factor of digital resolution. In this manner, the image enhancement taught by Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 6. Therefore, the teachings of Nakai et al. anticipate the method of claim 6.

15. *The following is in regard to Claim 8.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 4. The tone mapping function is implemented as a set of lookup tables (LUTs). See Nakai et al. Fig. 8 and column 10, lines 12-15 and lines 19-24. In this manner, the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 8. Therefore, the teachings of Nakai et al. anticipate the method of claim 8.

16. *The following is in regard to Claim 9.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 8. The LUTs implementing the tone mapping function are clearly used for color correction. That is, the tone properties (i.e. the corrected or mapped colors, or more specifically, the corresponding color correction factors – see Nakai et al. Fig. 8) within the LUTs are applied to the digital image so as to alter the tone values of the digital image, thereby producing an enhanced digital image having altered tone values. Again, refer to Nakai et al. and Fig. 8 and column 10, lines 12-15 and lines 19-24. In this

3 Representing the tone mapping function as such is legitimate. By adjusting the contrast of the color corrected image, the tone of the image is further corrected presumably through the improvement of contrast. An adjustment to the contrast will effect the tone of the image, including the extracted facial region. Furthermore, a filter applied to a 2D signal such as the image would be in the form of a matrix. Therefore, the color correction matrices of Nakai et al.'s color correction scheme can be coupled with the filter 40 of Nakai et al. Fig. 12, in a mathematical sense, to form a single tone mapping function for the image.

4 In claim 6, digital resolution can interpreted as the number of bits (bit-resolution) used to encode the color data of the image. This interpretation of digital resolution will be used in this document. It is consistent with the Applicant's disclosure.

manner, the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 9. Therefore, the teachings of Nakai et al. anticipate the method of claim 9.

17. *The following is in regard to Claims 11-12.* Claims 11-12 recite substantially the same limitations as claims 1-2, respectively. (These claims merely propose generic computer systems implementing the corresponding methods of claims 1-2). Therefore, with regard to claims 11-12, remarks analogous to those presented above with regard to claims 1-2 are respectively applicable.

18. *The following is in regard to Claim 13.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 12. In Nakai et al.'s method, the face area is "extracted therefrom through a process such as removing separate points, expanding, contracting, labeling and recognizing the shape" (Nakai et al. column 2, lines 43-47). This process effectively constitutes a face detection algorithm applied to the digital image. It has thus been shown that the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 13. Therefore, the teachings of Nakai et al. anticipate the system of claim 13.

19. *The following is in regard to Claim 14.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 13. By providing a mapping from uncorrected *flesh tones* to corrected *flesh tones,* the tone mapping function (see above) of Nakai et al.'s method incorporates "psychological factors". This is implied, for example, by Nakai et al. in column 2, lines 35-38. "Signal factors" influencing the tone mapping function of Nakai et al.'s method can include everything from the colors of the input digital image to the histogram derived from the digital image (Nakai et al. column 11, line 52). That is, the tone mapping function derived according to the method of Nakai et al. includes both "psychological factors" and "signal factors". In this manner, the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 14. Therefore, the teachings of Nakai et al. anticipate the system of claim 14.

20. *The following is in regard to Claim 16.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 14. Given the arguments above with respect to claim 6, it should be apparent that the tone mapping function of a system implementing the method of Nakai et al. incorporates

signal factors that include digital resolution and face region contrast. Therefore, the teachings of Nakai et al. anticipate the system of claim 16.

21. *The following is in regard to Claims 18-19.* Claims 18-19 recite substantially the same limitations as claims 1-2, respectively. (These claims merely propose generic computer systems implementing the corresponding methods of claims 1-2). Therefore, with regard to claims 18-19, remarks analogous to those presented above with regard to claims 1-2 are respectively applicable.

22. *The following is in regard to Claim 20.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 19. By providing a mapping from uncorrected *flesh tones* to corrected *flesh tones,* the tone mapping function (see above) of Nakai et al.'s method incorporates "psychological factors". This is implied, for example, by Nakai et al. in column 2, lines 35-38. "Signal factors" influencing the tone mapping function of Nakai et al.'s method can include everything from the colors of the input digital image to the histogram derived from the digital image (Nakai et al. column 11, line 52). That is, the tone mapping function derived according to the method of Nakai et al. includes both "psychological factors" and "signal factors". In this manner, the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 20. Therefore, the teachings of Nakai et al. anticipate the medium of claim 20.

23. *The following is in regard to Claim 23.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 18. The tone mapping function is implemented as a set of lookup tables (LUTs). See Nakai et al. Fig. 8 and column 10, lines 12-15 and lines 19-24. In this manner, the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 23. Therefore, the teachings of Nakai et al. anticipate the medium of claim 23.

24. *The following is in regard to Claim 24.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 23. The LUTs implementing the tone mapping function are clearly used for color correction. That is, the tone properties (i.e. the corrected or mapped colors, or more specifically, the corresponding color correction factors – see Nakai et al. Fig. 8) within the LUTs are applied to the digital image so as to alter the tone values of the digital image, thereby producing an enhanced digital image having altered tone values. Again, refer to Nakai et al. and Fig. 8 and column 10, lines 12-15 and lines 19-24. In this

manner, the color correction method of Nakai et al. sufficiently conforms to the image enhancement method proposed by the Applicant in claim 24. Therefore, the teachings of Nakai et al. anticipate the medium of claim 24.

Rejections Under 35 U.S.C. § 103(a)

25. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

26. Claims 5, 10, 15, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakai et al. in view of Sakatani et al. (U.S. Patent 6,587,225).

27. *The following is in regard to Claim 5.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 4. Nakai et al., however, do not expressly show or suggest that the psychological factors include average face region lightness and average picture lightness.

28. Sakatani et al. discloses an image processing apparatus, wherein the colors of an input digital image are mapped to those of an output digital image for the purposes of faithful color reproduction (Sakatani et al. Fig. 3). In much the same way as Nakai et al. (cf. Nakai et al. equation (3) and column 2, lines 7-12), Sakatani et al. proposes a mapping that minimizes the difference between the output color and the desired color (Sakatani et al. column 4, lines 44-49). Whereas Nakai et al. use individual samples of colors (e.g. (r,g,b) in Nakai et al. equations (1)-(3)) in their optimization, Sakatani et al. suggest the usage of an average or averages of colors. See Sakatani et al. column 4, lines 44-51. Note that the color spaces of Sakatani et al.'s apparatus (i.e. *L*a*b* and *CMYK*) contain luminance (lightness) information (i.e. L and Y, respectively).

29. The teachings of Nakai et al. and Sakatani et al. are combinable because they are analogous art. In particular, both Nakai et al. and Sakatani et al. teach methods of color correction that are based on the derivation of an optimized tone mapping. Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use average color, or more particularly average luminance, as opposed to

individual color or luminance samples in the multiple regression analysis (Nakai et al. column 1, lines 57-67 to column 2, lines 1-11) of the image and facial regions of Nakai et al.'s color correction methodology. Clearly, the motivation to use average luminance, in lieu of individual color samples, would have been to substantially reduce the computational complexity of the regression by reducing the size of the data set that the tone mapping function is fitted to. Combining the teachings of Nakai et al. and Sakatani et al., in the manner just described, would yield a tone enhancement method, wherein the tone mapping function includes the psychological factors of image color or luminance and facial region color or luminance. The method thus obtained sufficiently conforms to that which is claimed by the Applicant in claim 5.

30. *The following is in regard to Claim 10.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 1. Nakai et al., however, do not expressly show or suggest performing *L*a*b* conversion prior to performing face location (i.e. prior to step (1.a) above), and the converting the *L*a*b* converted digital image back into the original format after color correction has been performed (i.e. after step (1.d) above).

31. Sakatani et al. discloses an image processing apparatus, wherein the colors of an input digital image are mapped to those of an output digital image for the purposes of faithful color reproduction (Sakatani et al. Fig. 3). As shown in Sakatani et al. Fig. 1, *L*a*b* conversion (step 2 of Sakatani et al. Fig. 1 and column 3, lines 59-67 to column 4, lines 1-34) is performed prior to color correction (i.e. mapping step 3 in Sakatani Fig. 1) and the conversion back to the original color space (step 6 of Sakatani et al. Fig. 1) is performed after color correction.

32. The teachings of Nakai et al. and Sakatani et al. are combinable because they are analogous art. In particular, both Nakai et al. and Sakatani et al. teach methods of color correction that are based on the derivation of an optimized tone mapping. Taking into account the teachings of Sakatani et al., it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to perform *L*a*b* conversion prior to performing the color correction of Nakai et al.'s method (i.e. steps (1.a)-(1.d) above) and converting back to the original color space after the color correction has completed (i.e. after step (1.d)). The advantage of converting to the *L*a*b* color space, in this way, is that *L*a*b* color representations are known to be device-independent and, moreover, *L*a*b* models a human's visual perception of color more accurately than other device-dependent color

spaces such as *RGB* or *CMYK*. Incorporating *L*a*b* conversion into the tone enhancement method of Nakai et al., in this manner, yields a method for enhancing a digital image that is in accordance with claim 10.

33. *The following is in regard to Claim 15.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 14. Nakai et al., however, do not expressly show or suggest that the psychological factors include average face region lightness and average picture lightness.

34. As discussed above, given the teachings of Sakatani et al., it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use average color, or more particularly average luminance, as opposed to individual color or luminance samples in the multiple regression analysis (Nakai et al. column 1, lines 57-67 to column 2, lines 1-11) of the image and facial regions of Nakai et al.'s color correction methodology. From the preceding discussion relating to claim 5, it should be clear that combining the teachings of Nakai et al. and Sakatani et al., in the manner thus described, would yield a computer system that sufficiently conforms to that which is claimed by the Applicant in claim 15.

35. *The following is in regard to Claim 21.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 20. Nakai et al., however, do not expressly show or suggest that the psychological factors include average face region lightness and average picture lightness.

36. As discussed above, given the teachings of Sakatani et al., it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to use average color, or more particularly average luminance, as opposed to individual color or luminance samples in the multiple regression analysis (Nakai et al. column 1, lines 57-67 to column 2, lines 1-11) of the image and facial regions of Nakai et al.'s color correction methodology. From the preceding discussion relating to claim 5, it should be clear that combining the teachings of Nakai et al. and Sakatani et al., in the manner thus described, would yield a computer-readable storage medium that sufficiently conforms to that which is claimed by the Applicant in claim 21.

37. Claims 7 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakai et al. in view of Sonka et al. ("Image Processing, Analysis and Machine Vision", 2nd Edition), in further view of Materka et al. ("Texture Analysis Methods – A Review", University of Lodz Technical Report 1998).

38. *The following is in regard to Claim 7.* As shown above, Nakai et al. disclose a color correcting method that conforms to the image enhancement method proposed in claim 6. Nakai et al., however, do not expressly show or suggest that signal factors include histogram uniformity and noise information..

39. Sonka et al. discuss histogram equalization and its applicability to contrast enhancement. Refer to Sonka et al. page 60, paragraph 1. As Sonka et al. shows, with respect to histogram equalization, transforming images such that the entire range of brightness levels[5] are (approximately) equally distributed (i.e. transforming images so that they have *uniform* histograms – Sonka et al. Figure 4.2) results in images having enhanced contrast. Thus, Sonka et al. demonstrates the desirability of histogram[6] uniformity in image enhancing transformations.

40. The teachings of Sonka et al. and Nakai et al. are combinable because they are analogous art. Specifically, the teachings Sonka et al. and Nakai et al. (Nakai et al. column 11, line 53) are directed to image enhancement techniques utilizing histograms. Therefore, taking into account the teachings of Sonka et al., it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to supplement the signal factors influencing the tone mapping function of Nakai et al. (e.g. bit-resolution and image contrast – see above) with the signal factor of histogram uniformity. The motivation for doing so would have been to allow the tone mapping function to additionally provide enhanced contrast in the mapped tones. Despite this, neither Sonka et al. nor Nakai et al. directly show or suggest that the signal factors should further include noise information, though, as will be shown below, this feature is inherent.

41. Materka et al. describe various features of an image expressed in terms of the image's histogram (i.e. first order histogram-based features – Materka et al. Section 4.1). In particular, Materka et al. describes image entropy (Materka et al. page 8, equation (4.9)). According to Materka et al. (Materka et al. page 9, line 2), histogram

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5 Again, changes in brightness (luminance) result in a change in tone.

6 Histograms represent the statistical distribution of color, luminance, etc. in an image and can, therefore, be regarded as signal factors. Properties of histograms such as uniformity can likewise be regarded as signal factors, as well.

uniformity is related to image entropy. As is well-known in the field of information theory, entropy is a measure of the uncertainty associated with a signal (or, more precisely, a random variable). Accepting this definition and noting the fact that noisy signals are intrinsically entropic, it should be apparent that the entropy of an image is a measure of that image's noise. Therefore, by implication, histogram uniformity provides a measure of image noise. Consequently, supplementing the set of signal factors influencing the tone mapping function with the signal factor of histogram uniformity (as discussed above) simultaneously provides a signal factor of noise information or entropy (namely, the histogram uniformity), as shown by Materka et al.'s teachings.

42. The teachings of Materka et al. are combinable with those of Sonka et al. and Nakai et al because they are analogous art. Specifically, Materka et al. illustrate various histogram-based properties of an image, in particular histogram uniformity, while Sonka et al. and Nakai et al. demonstrate the usage of histograms in image enhancement. It should be clear, given the teachings of Materka et al., that supplementing the signal factors influencing the tone mapping function of Nakai et al. (e.g. bit-resolution and image contrast – see above) to include the signal factor of histogram uniformity, yields an image enhancement method, wherein the tone mapping function has signal factors including histogram uniformity and noise information. A method thus obtained sufficiently conforms to the image enhancement method of claim 7.

43. *The following is in regard to Claim 17.* As shown above, the teachings of Nakai et al. adequately address all subject matter put forth by the Applicant in claim 16. The limitations of claim 17 are substantially the same as claim 7. (This claim merely propose generic computer systems implementing the corresponding methods of claims 7). Therefore, with regard to claim 17, remarks analogous to those presented above with regard to claim 7 are applicable.

44. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nakai et al. in view of Sakatani et al., in further view of Sonka et al. and Materka et al.

45. *The following is in regard to Claim 22.* As shown above, the teachings of Nakai et al. and Sakatani et al., when combined in the manner discussed above, adequately address all subject matter put forth by the Applicant in

claim 21. While Nakai et al. shows digital resolution and facial contrast (see the discussion above relative to claim 6) as being signal factors influencing the tone mapping function, neither Nakai et al. nor Sakatani et al. show or suggest histogram uniformity as such a signal factor.

46. Sonka et al. discuss histogram equalization and its applicability to contrast enhancement. Refer to Sonka et al. page 60, paragraph 1. As Sonka et al. shows, with respect to histogram equalization, transforming images such that the entire range of brightness levels are (approximately) equally distributed (i.e. transforming images so that they have *uniform* histograms – Sonka et al. Figure 4.2) results in images having enhanced contrast. Thus, Sonka et al. demonstrates the desirability of histogram uniformity in image enhancing transformations.

47. The teachings of Sonka et al. are combinable with those of Nakai et al. and Sakatani et al. because they are analogous art. Specifically, the teachings Sonka et al., Nakai et al. and Sakatani et al. are all directed toward image enhancement techniques. Therefore, taking into account the teachings of Sonka et al., it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to supplement the signal factors influencing the tone mapping function of the method, obtained by combining the teachings of Nakai et al. and Sakatani et al., with the signal factor of histogram uniformity. The motivation for doing so would have been to allow the tone mapping function to additionally provide enhanced contrast in the mapped tones. A computer medium containing instructions implementing the method thus obtained sufficiently conforms to the medium of claim 22.

Citation of Relevant Prior Art

48. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure:

[1] *U.S. Patent 5,130,935.* Takiguchi. Publication Date: October 1995.

Similar in principle to the methodology and system of Nakai et al., Takiguchi discloses a method and apparatus for correcting the color of an input image in response to extracted regions of the image. In particular, Takiguchi locates facial regions having skin tones and attempts to map the observed colors to the desired, corrected regions of the color space. The

color space used by Takiguchi is incidentally a L*u*v color space which very similar to L*a*b. In many cases, these color spaces are interchangeable.

[2] *U.S. Patent Application Publication 2002/0172419A1.* Lin et al. Publication Date: November 2002.

Lin et al. disclose an image enhancement apparatus and a corresponding method using face detection to provide for automatic enhancement of appearances of an image based on knowledge of human faces in the image.

[3] *U.S. Patent 6,748,097.* Gindele et al. Publication Date: June 2004.

Gindele et al. disclose a method for varying one or more image attributes of a print made from a digital image. The method includes, among other things, tone correction and, of particular relevance to the Applicant's claimed invention, facial detection and facial tone correction.

[4] *U.S. Patent 5,528,339.* Buhr et al. Publication Date: June 1996.

Buhr et al. disclose a system and method of image reproduction in color with preferential tone mapping and color enhancement are provided in which the color enhancement and tone mapping are conducted in a prescribed manner in order to provide a reproduction having preferred visual characteristics. Buhr et al. provide a general theoretical discussion on the derivation of tone mapping functions, particularly those that map skin tones detected in the input image to corrected skin tones.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Siangchin whose telephone number is (703)305-7569. The examiner can normally be reached on 9:00am - 5:30pm, Monday - Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amelia Au can be reached on (703)308-6604. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Kevin Siangchin

Examiner
Art Unit 2623

ks - 07/10/04

AMELIA M. AU
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2600